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AIR MONITORING REPORT

EDMONTON METROPOLITAN AREA

Alberta
ENVIRONMENT

86-04620/

1980

AIR MONITORING REPORT
EDMONTON METROPOLITAN AREA

prepared by

AIR QUALITY CONTROL BRANCH

POLLUTION CONTROL DIVISION

ENVIRONMENTAL PROTECTION SERVICES

ALBERTA ENVIRONMENT

Edmonton,
Alberta
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SYNOPSIS

This report is an assessment of the ambient air quality in the Edmonton metropolitan area for the 1980 report year. The assessment is based on the results of the monitoring of various air pollutants by the Air Quality Control Branch of the Pollution Control Division of Alberta Environment from March 1, 1980 to February 28, 1981.

The emphasis is on comparing the data with the levels outlined in the Alberta Clean Air (Maximum Levels) Regulations.

The meteorological data and the air quality indices--numerical indicators of air quality, which are based on readings of sulphur dioxide, ozone, carbon monoxide, suspended particulate matter, and nitrogen dioxide--are also discussed in this report. Generally, the air quality was in the "good" index range.

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I. INTRODUCTION

The Air Quality Control Branch of Alberta Environment operates an on-going program of ambient air monitoring in the Edmonton metropolitan area. The objectives of this program are twofold: to provide data for the assessment of existing air quality; and to establish long-term trends in air quality. To achieve these goals, the Branch operates a comprehensive network of stations equipped to measure oxides of nitrogen, ozone, carbon monoxide, sulphur dioxide, total hydrocarbons, particulates and total sulphation.

The report summarizes the results of the monitoring of these air pollutants from March 1, 1980 to February 28, 1981. This period was chosen because it reflects the seasonal fluctuations of air pollution levels. The seasonal breakdown is as follows: Spring - March, April, May; Summer - June, July, August; Fall - September, October, November; Winter - December, January, February.

The data obtained during this report year are compared with the air quality Regulations, which stipulate the maximum permissible concentrations of contaminants in the ambient air. The "maximum permissible concentrations" are listed in the Alberta Clean Air (Maximum Levels) Regulations.

The "Source and Emission Inventories" for the pollutants are cited to provide information on the contribution of each major source (e.g. industry and motor vehicles) to the total emissions of each pollutant.

II. THE AIR MONITORING NETWORK

The network of air monitoring stations in the Edmonton metropolitan area is comprised of two units: the continuous ambient air monitoring network, which collects data on oxides of nitrogen, ozone, carbon monoxide, sulphur dioxide and total hydrocarbons; and the static and intermittent air monitoring network, which samples total sulphation and particulates - soiling index, suspended particulate matter (high-volume sampler) and total dustfall.

Figure 1 illustrates the locations of the three continuous air monitoring stations. The stations are designated EDMU, ERMU and EIMU. The designations refer to the general locations of the stations in the downtown, residential and industrial areas respectively. Table 1 lists the parameters that each station is equipped to monitor continuously and gives additional information about the stations.

The locations of the static and intermittent air monitoring stations are also shown in Figure 1. This network of stations is comprised of 24 exposure sites for measuring total sulphation and total dustfall and three sites for measuring soiling index and suspended particulate matter.

FIGURE 1

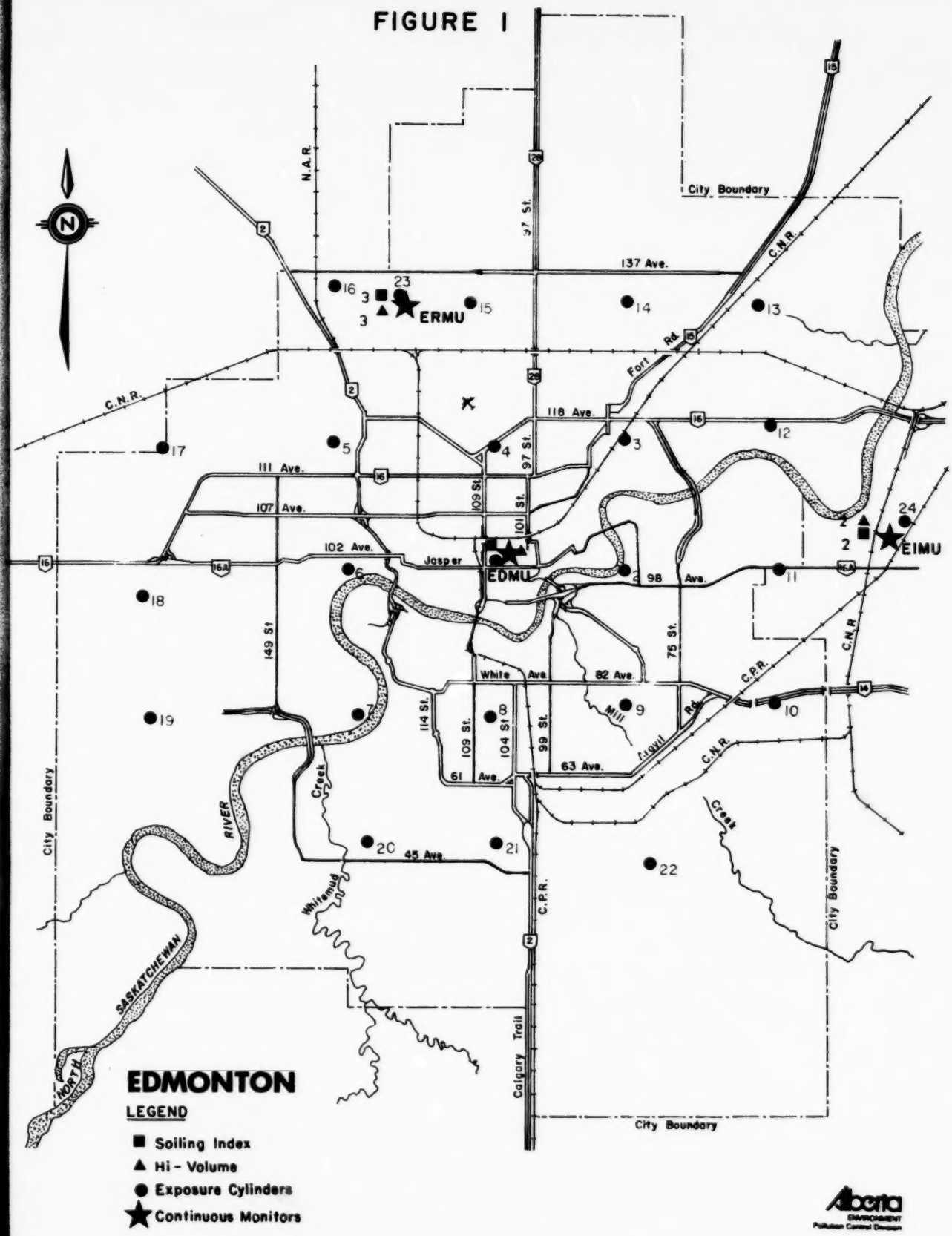
N
N.A.R.
C.N.R.
137 Ave.
City Boundary
97 St.
ERMU
Fort Rd.
118 Ave.
111 Ave.
107 Ave.
102 Ave.
Jasper
EDMU
EIMU
98 Ave.
109 St.
101 St.
97 St.
149 St.
75 St.
White Ave.
82 Ave.
C.P.R.
Mill Creek
114 St.
109 St.
104 St.
99 St.
63 Ave.
61 Ave.
45 Ave.
Whitemud Creek
RIVER
SASKATCHEWAN
NORTH
Calgary Trail
City Boundary
EDMONTON
LEGEND
Soiling Index
Hi - Volume
Exposure Cylinders
Continuous Monitors
Alberta
ENVIRONMENT
Pollution Control Division

TABLE 1

THE CONTINUOUS AMBIENT AIR MONITORING NETWORK

Parameters that Stations are Equipped to Monitor Continuously

Station	Wind	NO_x	NO_2	O_3	CO	SO_2	THC
EDMU	-	X	X	X	X	X	X
EIMU	X	X	X	X	X	X	X
ERMU	X	X	X	X	X	X	X

Note: EDMU - Edmonton Downtown Monitoring Unit
EIMU - Edmonton Industrial Monitoring Unit
ERMU - Edmonton Residential Monitoring Unit

NO_x - Oxides of Nitrogen
NO_2 - Nitrogen Dioxide
O_3 - Ozone
CO - Carbon Monoxide
SO_2 - Sulphur Dioxide
THC - Total Hydrocarbons

Station Documentation

Station	Station Address	Height of Station	Height of Sample Inlet Above Ground
EDMU	104 St. and 103 Ave.	5.5 m	8.5 m
EIMU	17 St. and 105 Ave.	2.5 m	5.0 m
ERMU	127 St. and 133 Ave.	2.5 m	3.5 m

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III. THE AIR MONITORING INSTRUMENTATION

The detection principles and sampling periods of the pollutants monitored during the 1980 report year are presented in Table 2. Also included are the methods used to calibrate the instruments and the type of monitoring that was employed for each pollutant.

There are three basic types of ambient air monitoring, and they differ on the basis of the duration of the sampling periods: continuous, static and intermittent. Continuous monitoring is the sampling of the air on a continuous basis; static monitoring involves time periods of approximately 30 days; and intermittent monitoring encompasses 1-hour, 2-hour and 24-hour sampling time periods.

Monitoring of ambient air may also be categorized according to the method used for analyzing the sample, automatic or manual. Automatic analysis is accomplished by a system which has the capability of collecting the sample, analyzing it and giving a data read-out. This is exemplified by the monitoring of oxides of nitrogen, ozone, carbon monoxide, sulphur dioxide and total hydrocarbons. Manual analysis involves the collection of a sample and subsequent analysis at a laboratory. The monitoring of particulates and total sulphation are examples of the manual method.

TABLE 2

THE AIR MONITORING INSTRUMENTATION

Pollutant	Detection Principle	Sampling Period	Type of Monitoring	Instrument Calibration Method
Nitrogen Dioxide	Chemiluminescence	Instantaneous (sample integration)	Continuous	Gas phase titration or Certified gas cylinder
Ozone	Chemiluminescence or Ultraviolet photometry	Instantaneous (sample integration)	Continuous	Gas phase titration
Carbon Monoxide	Nondispersive infrared radiation	Instantaneous (sample integration)	Continuous	Certified gas cylinder
Sulphur Dioxide	Coulometric detection or Pulsed fluorescence	Instantaneous (sample integration)	Continuous	Permeation tube
Total Hydrocarbons	Flame ionization	Instantaneous (sample integration)	Continuous	Certified gas cylinder
Suspended Particulate Matter (Soiling Index)	Tape sampler (light transmittance)	1-hour or 2-hour	Intermittent	Rotameter - flow
Suspended Particulate Matter (High-Volume Sampler)	Gravimetry	24-hour	Intermittent	Orifice plates
Total Sulphation	Chemical reaction	30 days	Static	N/A
Total Dustfall	Gravimetry	30 days	Static	N/A

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IV. AIR POLLUTANT DATA ANALYSES

A. INTRODUCTION

In this section of the report, the pollutants are examined on an individual basis. The presentation includes general information on the pollutants, an overview of the prime emission sources as determined by the 1973 Source and Emission Inventory and an analysis of the data.

For the purposes of this report, the data are summarized. The summaries include arithmetic mean concentrations and the frequency of occurrence of concentrations in compliance with the Clean Air (Maximum Levels) Regulations.

Sufficient data must be available to constitute valid calculated mean values. When the instrument operational time is less than 50%, no arithmetic mean is calculated; and when the instrument is operational between 50% and 75% of the time, the arithmetic mean may not be representative of that period. Therefore, any comparisons of the data should take this into account.

Tables 3 and 4 are included to provide an overall picture of existing air quality and to give some idea of the trends of the air pollution levels over the past five years. Starting with the 1982 annual report, a detailed trend analysis section will be included.

TABLE 3

POLLUTANTS COMPARED WITH REGULATIONS[1]

MAR. 1, 1980 - FEB. 28, 1981

POLLUTANT	PERCENT COMPLIANCE WITH REGULATIONS[1]			AIR QUALITY REGULATIONS
	EDMU	EIMU	ERMU	
Nitrogen Dioxide				
1-hour	99.97	100	100	0.21 ppm
24-hour	100	100	100	0.11 ppm
Ozone				
1-hour	100	99.92	100	0.080 ppm
24-hour	93.08	70.68	85.36	0.025 ppm
Carbon Monoxide				
1-hour	99.73	100	99.57	13.0 ppm
8-hour	92.11	100	94.36	5.0 ppm
Sulphur Dioxide				
1-hour	100	100	100	0.17 ppm
24-hour	100	100	100	0.06 ppm
Suspended Particulate Matter (Soiling Index-COH)	100	100	91.63	A minimum of 90% of readings per month shall be less than 1.0 COH.
Suspended Particulate Matter (High-Volume Sampler)	39.28	71.93	66.66	100 $\mu g/m^3$/24hr
Total Dustfall[2]				
Residential and Recreational Area Stations		57.06		53 mg/100 cm^2/30 days
Commercial and Industrial Area Stations		72.12		158 mg/100 cm^2/30 days

[1] Clean Air (Maximum Levels) Regulations.
[2] No allowance made for normal background levels as required by (1).

TABLE 4

ANNUAL CONCENTRATION MEANS IN EDMONTON

(1976-1980)

		1976	1977	1978	1979	1980
Nitrogen Dioxide (ppm)	EDMU	0.05	0.04	0.04	0.04	0.04
	EIMU	0.01	0.02	0.02	0.02	0.02
	ERMU	0.02	0.02	0.03	0.03	0.02
Ozone (ppm)	EDMU	0.022	0.014	0.009	0.012	0.012
	EIMU	0.023	0.015	0.017	0.023	0.019
	ERMU	0.025	0.015	0.017	0.019	0.015
Carbon Monoxide (ppm)	EDMU	1.6	2.1	2.2	3.3	2.8
	EIMU	0.6	0.3	0.4	0.4	0.8
	ERMU	1.8	1.5	1.3	1.9	1.9
Total Hydrocarbons (ppm)	EDMU	2.0	2.0	2.2	1.8	2.1
	EIMU	2.4	2.6	3.6	2.5	2.5
	ERMU	2.4	2.1	2.4	2.6	2.5
Total Sulphation 24 Stations (SO_3 equiv. mg/100cm^2/day)		0.09	0.13	0.11	0.10	0.16
Suspended Particulate Matter Soiling Index (COH Units)	EDMU	0.20	0.19	0.20	0.27	0.32
	EIMU	0.04	0.10	0.14	0.21	0.23
	ERMU	0.11	0.09	0.17	0.25	0.29
Suspended Particulate Matter High-Volume Sampler µg/m^3 (Geometric Mean)	EDMU	89	93	83	102	104
	EIMU	59	60	66	77	72
	ERMU	69	62	66	92	81
Total Dustfall						
Residential and Recreational Area Stations (15) mg/100 cm^2/30 days		77	52	49	51	65
Commercial and Industrial Area Stations (9) mg/100 cm^2/30 days		112	94	102	140	125

B. OXIDES OF NITROGEN (NO_x)

Oxides of nitrogen are composed of two major constituents: nitrogen dioxide (NO_2) and the less toxic nitric oxide (NO). Both pollutants originate from natural and man-made processes. Nitrogen and oxygen, the principle constituents of the atmosphere, combine during high temperature combustion to form NO_x.[1] The major man-made source is from the burning of fossil fuels such as natural gas, coal, oil and gasoline.

In the Edmonton metropolitan area, motor vehicles contribute about half of the oxides of nitrogen emissions, electric power generation contributes about 30 percent, and natural gas combustion from sources such as home heating contributes 15 percent (Figure 2 - "Source and Emission Inventory").

The major oxide of nitrogen at the point of combustion is nitric oxide. A small fraction of the nitric oxide is converted to nitrogen dioxide by photochemical oxidation. Since it has been demonstrated that nitrogen dioxide can cause deleterious effects, and is the more toxic oxide of nitrogen, the emphasis here will be placed on nitrogen dioxide.

Nitrogen dioxide is an orange-brown gas with a characteristic pungent odour. Because of its colouration, it has been postulated that NO_2 is responsible for a portion of the brownish discolouration of air masses near urban areas.

The results of the monitoring of NO_2 during the 1980 report period are presented in Table 5 and Figure 2. All three monitoring stations reported 100% compliance with the 24-hour NO_2 Regulation. Also, all three stations reported 100% compliance with the 1-hour NO_2 Regulation except for the months of May and January at EDMU, which had 99.9% and 99.8% compliance respectively. Vehicular traffic exhaust is responsible for the small amount of non-compliance time.

TABLE 5
NITROGEN DIOXIDE/OXIDES OF NITROGEN

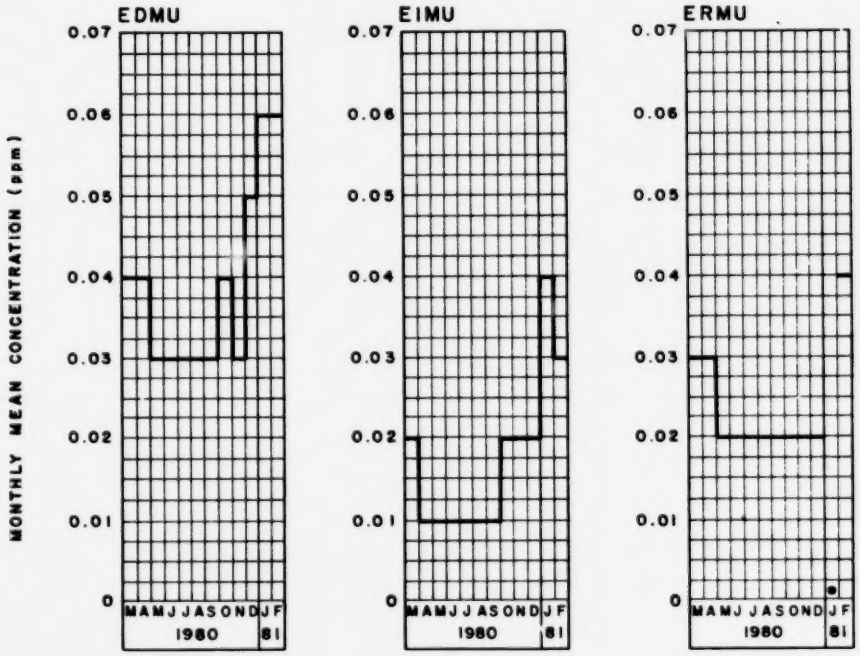
MAXIMUM LEVELS REGULATIONS (NO_2)
1-HOUR-0.21 PPM 24-HOUR-0.11 PPM

MONTH	ARITHMETIC MEAN (ppm)		PERCENTAGE OF TIME INSTRUMENT OPERATIONAL		PERCENT COMPLIANCE WITH NO_2 REGULATIONS	
	NO_2	NO_x	NO_2	NO_x	1-HR	24-HR
EDMU						
March '80	0.04	0.09	97.2	96.8	100	100
April	0.04	0.07	97.8	97.8	100	100
May	0.03	0.05	99.1	94.4	99.9	100
June	0.03	0.05	98.1	96.0	100	100
July	0.03	0.05	90.6	90.6	100	100
August	0.03	0.06	96.8	96.8	100	100
September	0.03	0.08	96.4	96.4	100	100
October	0.04	0.12	97.4	97.4	100	100
November	0.03	0.11	97.4	97.4	100	100
December	0.05	0.13	92.2	92.2	100	100
January '81	0.06	0.16	89.0	89.0	99.8	100
February	0.06	0.12	92.9	92.9	100	100
EIMU						
March '80	0.02	0.04	100	100	100	100
April	0.01	0.02	100	100	100	100
May	0.01	0.02	99.1	98.0	100	100
June	0.01	0.02	89.4	89.4	100	100
July	0.01	0.03	76.5	76.5	100	100
August	0.01	0.02	91.7	92.6	100	100
September	0.01	0.03	98.1	98.1	100	100
October	0.02	0.05	98.4	98.4	100	100
November	0.02	0.06	82.5	92.5	100	100
December	0.02	0.05	92.7	92.7	100	100
January '81	0.04	0.08	96.8	96.8	100	100
February	0.03	0.06	96.4	96.4	100	100
ERMU						
March '80	0.03	0.06	100	100	100	100
April	0.03	0.04	99.0	99.0	100	100
May	0.02	0.04	99.1	99.1	100	100
June	0.02	0.04	98.8	90.8	100	100
July	0.02	0.04	93.5	94.0	100	100
August	0.02	0.04	94.4	95.0	100	100
September	0.02	0.07	97.1	97.1	100	100
October	0.02	0.09	96.8	96.8	100	100
November	0.02	0.09	94.3	94.4	100	100
December	0.02	0.08	94.8	94.8	100	100
January '81	a.	a.	36.2	36.2	100	100
February	0.04	0.09	75.0	75.0	100	100

a.-Instrument operational less than 50%; insufficient data for calculation of mean.

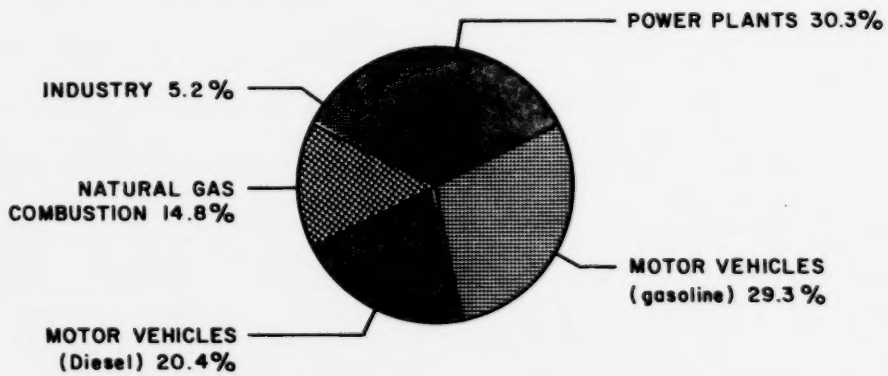
FIGURE 2 - OXIDES OF NITROGEN

NO_2 MONTHLY MEANS



• INSUFFICIENT DATA FOR CALCULATION OF MEAN.

SOURCE AND EMISSION INVENTORY



RELATIVE CONTRIBUTION OF EACH CATEGORY TO TOTAL OXIDES OF NITROGEN EMISSIONS IN THE EDMONTON AREA , 1973

OXIDES OF NITROGEN 19,973 TONS

Alberta ENVIRONMENT
Pollution Control Division
Air Quality Control Branch

C. OZONE (O_3)

Unlike many other pollutants, ozone is not introduced directly to the air by man's activities. In the upper atmosphere, ozone is a naturally occurring constituent; in the lower atmosphere or ambient air, ozone is the primary end-product of photochemical oxidation involving the nitrogen oxides, ultraviolet light energy and reactive hydrocarbons. Ozone plays an important role in the absorption of harmful ultraviolet radiation in the upper atmosphere; however, in ambient air it can be harmful to humans, vegetation and various materials.

Table 6 and Figure 3 present a summary of the ozone data collected for this report year. Several observations can be made: there was a frequent occurrence of readings in excess of the Clean Air (Maximum Levels) Regulations for a 24-hour period; EIMU was the only station recording 1-hour contraventions; ERMU and EIMU recorded higher levels than EDMU; and the ozone levels were highest during the spring and summer months at all three stations.

The high frequency of readings in excess of the 24-hour Regulation is attributable to the high natural levels of ozone in Alberta, constituting what is referred to as "background" levels. The background levels can fluctuate depending on environmental conditions and can exceed the 24-hour Regulation.[2]

The higher concentrations of ozone recorded at ERMU and EIMU, relative to EDMU, may not be indicative of local sources but may have resulted from wind transportation of the precursors to those areas. The elevated readings in spring and summer are indicative of the increase in ultraviolet light energy, which enhances the photochemical production of ozone.

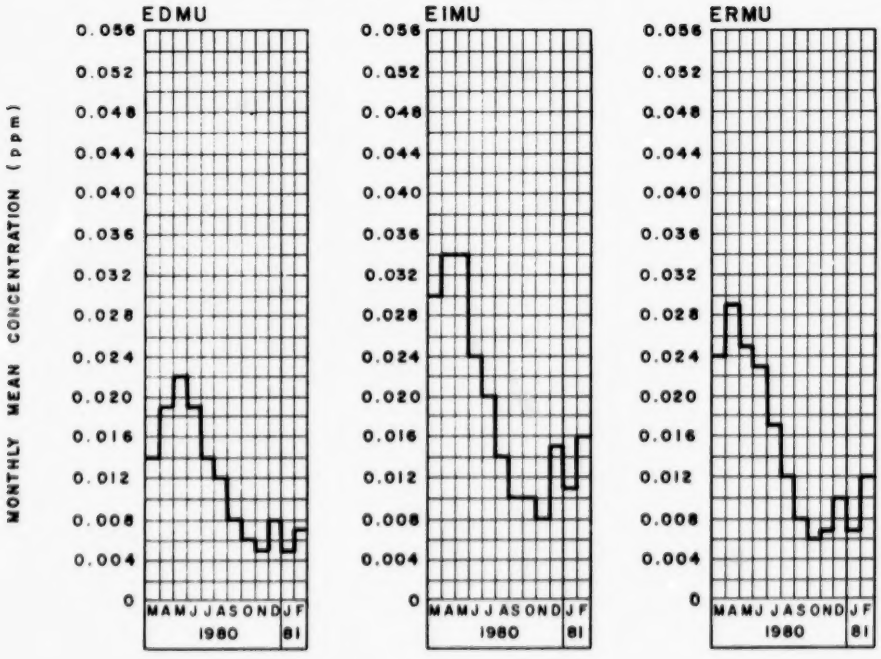
TABLE 6
OZONE

MAXIMUM LEVELS REGULATIONS
1-HOUR-0.080 PPM 24-HOUR-0.025 PPM

MONTH	ARITHMETIC MEAN (ppm)	PERCENTAGE OF TIME INSTRUMENT OPERATIONAL	PERCENT COMPLIANCE WITH REGULATIONS	
			1-HR	24-HR
EDMU				
March '80	0.014	100	100	100
April	0.019	99.3	100	90.0
May	0.022	100	100	64.5
June	0.019	99.4	100	83.2
July	0.014	90.9	100	96.4
August	0.012	95.4	100	100
September	0.008	86.7	100	100
October	0.006	96.2	100	100
November	0.005	95.8	100	100
December	0.008	93.1	100	100
January '81	0.005	89.7	100	100
February	0.007	95.1	100	100
EIMU				
March '80	0.030	100	100	16.1
April	0.034	99.7	99.7	3.3
May	0.034	91.9	99.3	26.3
June	0.024	83.8	100	60.2
July	0.020	99.1	100	73.9
August	0.014	92.1	100	89.5
September	0.010	97.5	100	100
October	0.010	97.4	100	100
November	0.008	95.8	100	100
December	0.015	95.4	100	93.2
January '81	0.011	95.7	100	96.6
February	0.016	95.5	100	92.5
ERMU				
March '80	0.024	91.1	100	65.4
April	0.029	92.5	100	29.7
May	0.025	91.8	100	40.3
June	0.023	91.5	100	74.5
July	0.017	95.7	100	86.5
August	0.012	95.0	100	100
September	0.008	93.9	100	100
October	0.006	95.6	100	100
November	0.007	95.7	100	100
December	0.010	92.7	100	96.5
January '81	0.007	96.4	100	100
February	0.012	91.1	100	88.2

FIGURE 3 - OZONE

MONTHLY MEANS



SOURCE AND EMISSION INVENTORY

SINCE OZONE IS PRIMARILY A PRODUCT OF PHOTOCHEMICAL REACTION, THE SOURCE AND EMISSION INVENTORY IS NOT APPLICABLE.

D. CARBON MONOXIDE (CO)

Carbon monoxide is an odourless, colourless gas. It is emitted into the atmosphere in greater quantities than any other urban air pollutant. The majority of the carbon monoxide found in urban air comes from man-made sources. Natural sources, such as forest fires and plant decay, maintain a very low background level.

The 1973 "Source and Emission Inventory" for the Edmonton metropolitan area (Figure 4) indicates that industry is the major source of CO, with motor vehicles being the second largest contributor. However, with the increase in vehicular traffic over the years, the contribution of the motor vehicle to the total CO emissions may have surpassed that contributed by industry.

There were averages of 99.8% compliance and 95.5% compliance respectively with the 1-hour and the 8-hour carbon monoxide Regulations, averaged for all three monitoring stations for the report year. Vehicular traffic exhaust is responsible for the small amount of non-compliance time.

The higher carbon monoxide levels monitored at EDMU and ERMU, relative to EIMU, (Table 7 and Figure 4) are indicative of the vehicular traffic density in the downtown and residential areas respectively. Diurnal variations of CO levels indicate that peak levels occur during or immediately following peak rush hour periods. The data also indicate that the lowest CO concentrations were monitored during the spring and summer seasons at all three monitoring stations (with the exception of March, 1980 at EDMU). This seasonal variation of CO levels results from changes in meteorological parameters. In the fall and winter, the colder ambient temperatures result in increased production of CO emissions from motor vehicles. In addition, the more stable atmospheric

conditions and low wind speeds which occur during the fall and winter result in decreased dispersion of CO emissions and consequently higher ground level CO concentrations, relative to spring and summer concentrations.

TABLE 7
CARBON MONOXIDE

MAXIMUM LEVELS REGULATIONS
1-HOUR-13 PPM 8-HOUR-5 PPM

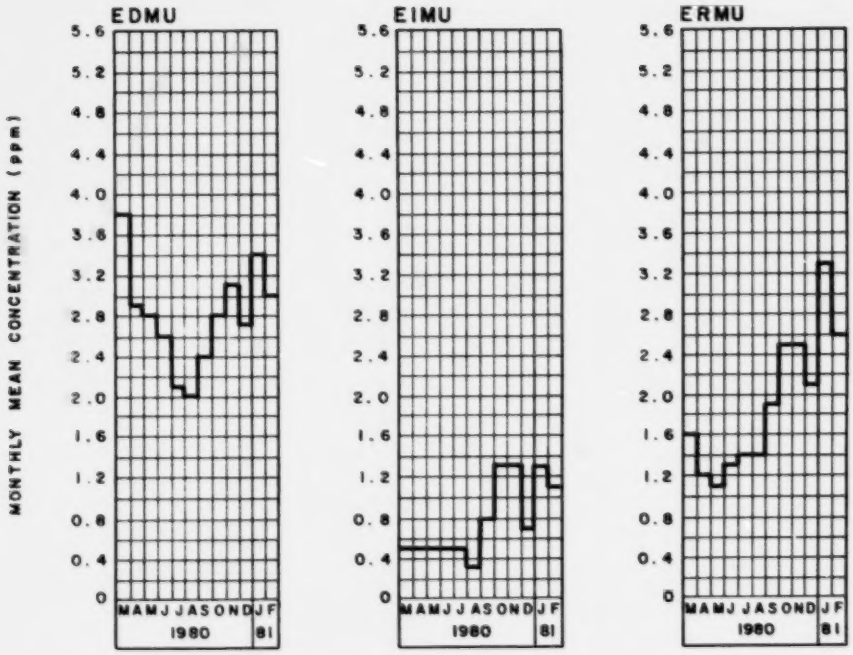
MONTH	ARITHMETIC MEAN (ppm)	PERCENTAGE OF TIME INSTRUMENT OPERATIONAL	PERCENT COMPLIANCE WITH REGULATIONS	
			1-HR	8-HR
EDMU				
March '80	3.8	100	99.9	72.0
April	2.9	99.9	100	93.3
May	2.8	99.7	100	96.8
June	2.6	99.9	100	97.8
July	2.1	95.7	100	100
August	2.0	96.8	100	100
September	2.4	96.7	99.9	97.7
October	2.8	97.4	99.6	93.4
November	3.1	97.2	99.6	88.6
December	2.7	95.4	99.6	91.0
January '81	3.4	91.4	98.2	84.7
February	3.0	97.0	100	90.2
EIMU				
March '80	0.5	91.1	100	100
April	0.5	96.3	100	100
May	0.5[a]	74.5	100	100
June	0.5	81.5	100	100
July	0.5	96.5	100	100
August	0.3	88.7	100	100
September	0.8	97.1	100	100
October	1.3	98.5	100	100
November	1.3	97.6	100	100
December	0.7	92.9	100	100
January '81	1.3	97.4	100	100
February	1.1	97.2	100	100
ERMU				
March '80	1.6	97.4	99.9	100
April	1.2	99.9	100	100
May	1.1	99.1	100	100
June	1.3[a]	61.5	100	100
July	1.4	89.8	99.7	98.8
August	1.4	96.9	100	100
September	1.9	97.1	99.9	94.3
October	2.5	97.4	99.4	90.1
November	2.5	97.1	99.7	90.8
December	2.1	97.2	99.7	92.3
January '81	3.3	97.8	97.7	79.1
February	2.6	95.7	99.1	88.8

a.-Instrument operational less than 75%; monthly mean may not be representative.

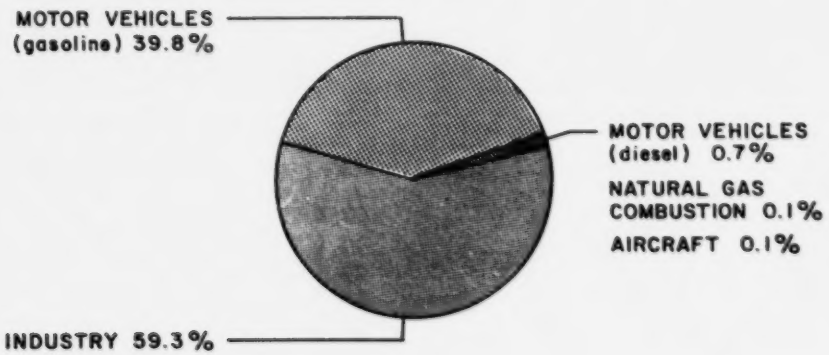
Alberta ENVIRONMENT Pollution Control Division Air Quality Control Branch

FIGURE 4 - CARBON MONOXIDE

MONTHLY MEANS



SOURCE AND EMISSION INVENTORY



RELATIVE CONTRIBUTION OF EACH CATEGORY TO TOTAL CARBON MONOXIDE EMISSIONS IN THE EDMONTON AREA, 1973

CARBON MONOXIDE
379,200 TONS

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Pollution Control Division
Air Quality Control Branch

E. SULPHUR DIOXIDE (SO_2)

Sulphur dioxide constitutes one of the major air pollutants on a global basis. It may oxidize and combine with moisture to form sulphuric acid and, as such, increase its harmful effects on vegetation and the respiratory systems of humans and animals. When combined with particulate matter, it exerts a synergistic effect that is more harmful than the effect of either pollutant.

Sulphur dioxide pollution results primarily from man-made sources such as combustion of fossil fuels, smelting and roasting of sulphur containing ores, kraft and sulphite wood pulping and sour gas processing. In Alberta, an estimated 295 thousand metric tons of sulphur were emitted into the atmosphere from man-made (primarily industrial operations) sources during 1980. About 51 percent of the sulphur emissions was contributed by sulphur extraction plants; oil sands plants and power plants contributed about 25 percent and 11 percent respectively. The remaining 13 percent came from sources such as gas plant flares, oil refineries, pulp and paper mills and fertilizer plants.[3]

A summary of the sulphur dioxide data collected during the 1980 report period is presented in Table 8. All sulphur dioxide readings were well below the Regulations, resulting in 100% compliance.

Figure 5 illustrates the SO_2 "Source and Emission Inventory" for the Edmonton area and includes a graph of total sulphation levels. Although the total sulphation cylinders are static monitors and yield only monthly average values, the data do provide valuable trend information and, therefore, are included in this section.

The lowest total sulphation levels of the period occurred in May, 1980 (0.06 mg. SO_3 equiv./day/100 sq. cm.), with the highest level occurring in November, 1980. All monthly mean concentration levels were below the 0.5 mg. SO_3 equiv./day/100 sq. cm. guideline (Figure 5).

TABLE 8
SULPHUR DIOXIDE

MAXIMUM LEVELS REGULATIONS
1-HOUR-0.17 PPM 24-HOUR-0.06 PPM

MONTH	ARITHMETIC MEAN (ppm)	PERCENTAGE OF TIME INSTRUMENT OPERATIONAL	PERCENT COMPLIANCE WITH REGULATIONS	
			1-HR	24-HR
EDMU				
March '80	0.00	100	100	100
April	0.00	99.4	100	100
May	0.00	81.0	100	100
June	0.00	98.1	100	100
July	0.00	91.4	100	100
August	0.00	95.6	100	100
September	0.00	86.7	100	100
October	0.00	96.2	100	100
November	0.00	92.2	100	100
December	0.00	92.6	100	100
January '81	0.00	89.9	100	100
February	0.00	94.9	100	100
EIMU				
March '80	0.00	89.5	100	100
April	0.00	99.7	100	100
May	0.00	99.3	100	100
June	0.00	87.9	100	100
July	0.00	98.5	100	100
August	0.00	91.8	100	100
September	0.00	97.4	100	100
October	0.00	97.0	100	100
November	0.00	95.8	100	100
December	a.	47.6	100	100
January '81	0.00	96.0	100	100
February	0.00	95.8	100	100
ERMU				
March '80	0.00	91.0	100	100
April	0.00	98.6	100	100
May	0.00	99.6	100	100
June	0.00	98.8	100	100
July	0.00	94.6	100	100
August	0.00	94.0	100	100
September	0.00	95.7	100	100
October	0.00	85.8	100	100
November	0.00	91.8	100	100
December	0.00	94.0	100	100
January '81	0.00	94.9	100	100
February	0.00	95.2	100	100

a.-Instrument operational less than 50%; insufficient data for calculation of mean.

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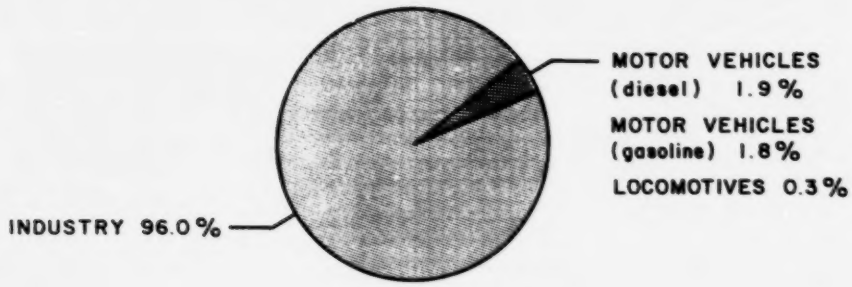
FIGURE 5 - SULPHUR DIOXIDE

NOTE

THE MONTHLY MEAN CONCENTRATIONS WERE 0.00 ppm THROUGHOUT THE REPORT YEAR AT ALL THREE STATIONS.

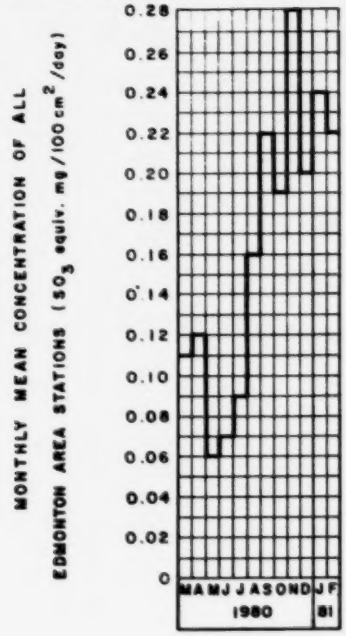
SOURCE AND EMISSION INVENTORY



RELATIVE CONTRIBUTION OF EACH CATEGORY TO TOTAL SULPHUR DIOXIDE EMISSIONS IN THE EDMONTON AREA, 1973

SULPHUR DIOXIDE 15,591 TONS

MONTHLY MEAN TOTAL SULPHATION LEVELS



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F. TOTAL HYDROCARBONS (THC)

The hydrocarbons considered in this section are those which exist in the atmosphere in the gaseous phase. They are important because they are precursors of compounds formed in the atmospheric photochemical system. Therefore, any assessment of the effects of hydrocarbon pollution must be made in relation to the effects of photochemical air pollution.

The natural sources of the gas-phase hydrocarbons, of which methane is a major constituent, include trees and vegetation. For man-made sources, the "Source and Emission Inventory" (Figure 6) indicates that industry is the primary source, with motor vehicles being the second largest contributor. The industrial emissions originate primarily from hydrocarbon storage, whereas the motor vehicle emissions result from inefficient combustion. Inefficient combustion, which occurs before the vehicle reaches operating temperature, is particularly evident during the winter.

The levels of total hydrocarbons monitored during this report period (Table 9 and Figure 6) did not show any definitive trends on a seasonal basis. The lowest average readings of the three stations generally occurred at the downtown station, EDMU, while the industrial station, EIMU, showed the highest average readings of the three stations. This station is located in the vicinity of hydrocarbon storage and processing facilities, which explains why these higher average readings were monitored throughout the report year.

Currently there are no air quality Regulations for hydrocarbons.

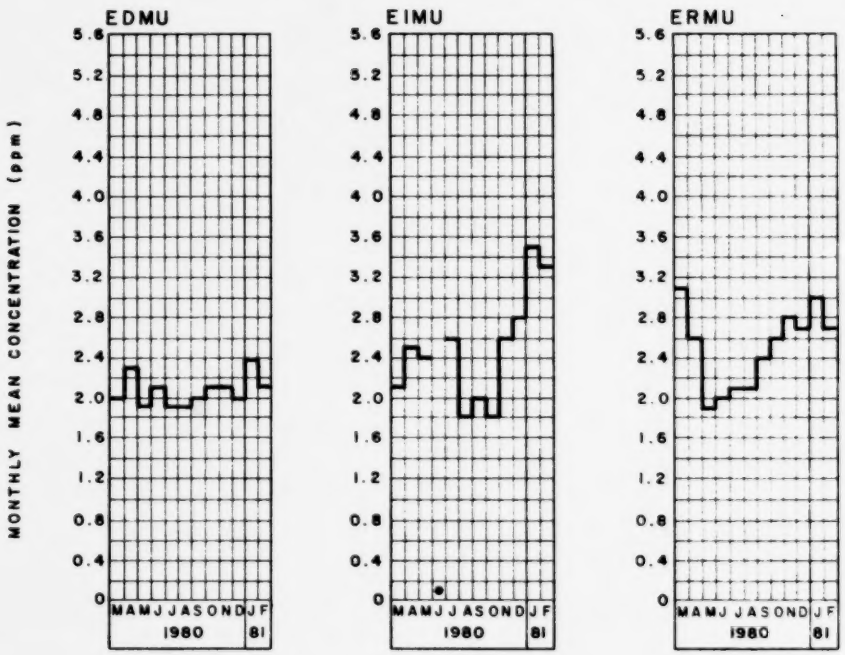
TABLE 9
TOTAL HYDROCARBONS

MONTH	ARITHMETIC MEAN (ppm)	PERCENTAGE OF TIME INSTRUMENT OPERATIONAL	PERCENT COMPLIANCE WITH REGULATIONS	
			1-HR	24-HR
EDMU				
March '80	2.0	86.6	NO REGULATION	
April	2.3	99.7		
May	1.9[a]	51.3		
June	2.1	94.9		
July	1.9[a]	62.6		
August	1.9	95.2		
September	2.0	96.5		
October	2.1	97.4		
November	2.1	97.2		
December	2.0	85.5		
January '81	2.4	91.4		
February	2.1	93.6		
EIMU				
March '80	2.1	85.6	NO REGULATION	
April	2.5	95.0		
May	2.4	100		
June	b.	39.2		
July	2.6[a]	71.0		
August	1.8	92.7		
September	2.0	88.8		
October	1.8	75.0		
November	2.6	93.8		
December	2.8	78.6		
January '81	3.5	91.5		
February	3.3	96.6		
ERMU				
March '80	3.1	98.9	NO REGULATION	
April	2.6	99.4		
May	1.9	89.7		
June	2.0	99.6		
July	2.1	75.4		
August	2.1	96.5		
September	2.4	94.0		
October	2.6	93.5		
November	2.8	96.9		
December	2.7	93.4		
January '81	3.0	96.4		
February	2.7	97.0		

a.-Instrument operational less than 75%; monthly mean may not be representative.
b.-Instrument operational less than 50%; insufficient data for calculation of mean.

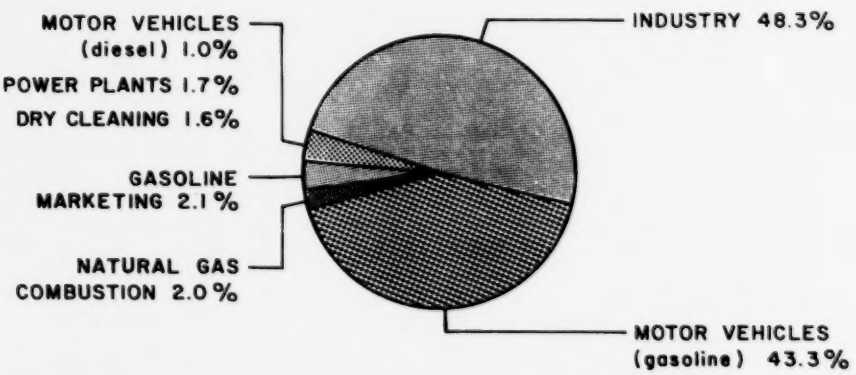
FIGURE 6 - TOTAL HYDROCARBONS

MONTHLY MEANS



• INSUFFICIENT DATA FOR CALCULATION OF MEAN.

SOURCE AND EMISSION INVENTORY



RELATIVE CONTRIBUTION OF EACH CATEGORY TO TOTAL HYDROCARBON EMISSIONS IN THE EDMONTON AREA, 1973

HYDROCARBONS 39,019 TONS

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Air Quality Control Branch

G. PARTICULATES

Particulate matter is composed of a wide variety of substances and encompasses any matter dispersed in the air where the individual particles are smaller in diameter than 500 microns (μ). It is the most commonly perceived form of pollution, often manifesting itself by interference with visibility, a soiling effect on materials or as a respiratory irritant. The characteristics of particles and particle dispersion are shown in Figure 7.

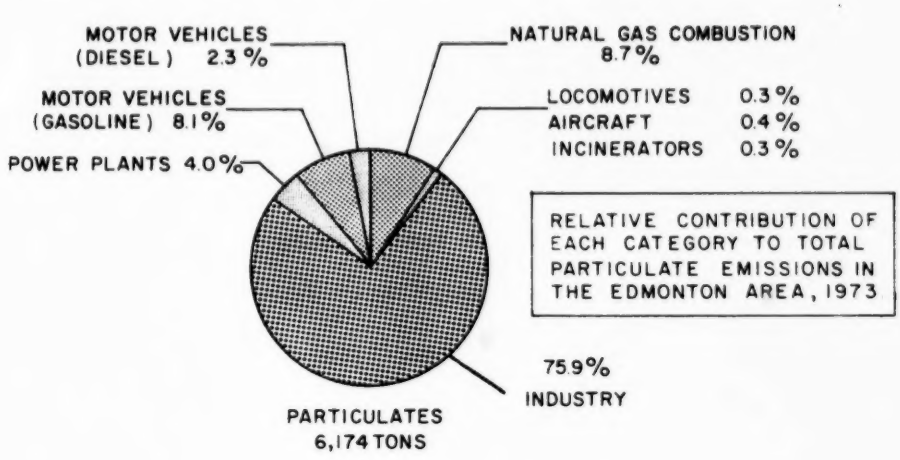
The "Source and Emission Inventory" (Figure 7) indicates that industry is the primary source of particulate emissions. Dust from sources such as wind erosion and construction activities is not included in this inventory, although it may in fact be the greatest overall source.

In the Edmonton metropolitan area, three types of sampling units are employed to measure particulate matter; therefore, the results for each type will be discussed separately in subsequent sections. The three types of samplers are the tape sampler, the high-volume sampler and the dustfall cylinder. The first two samplers measure suspended particulate matter while the latter measures total dustfall.

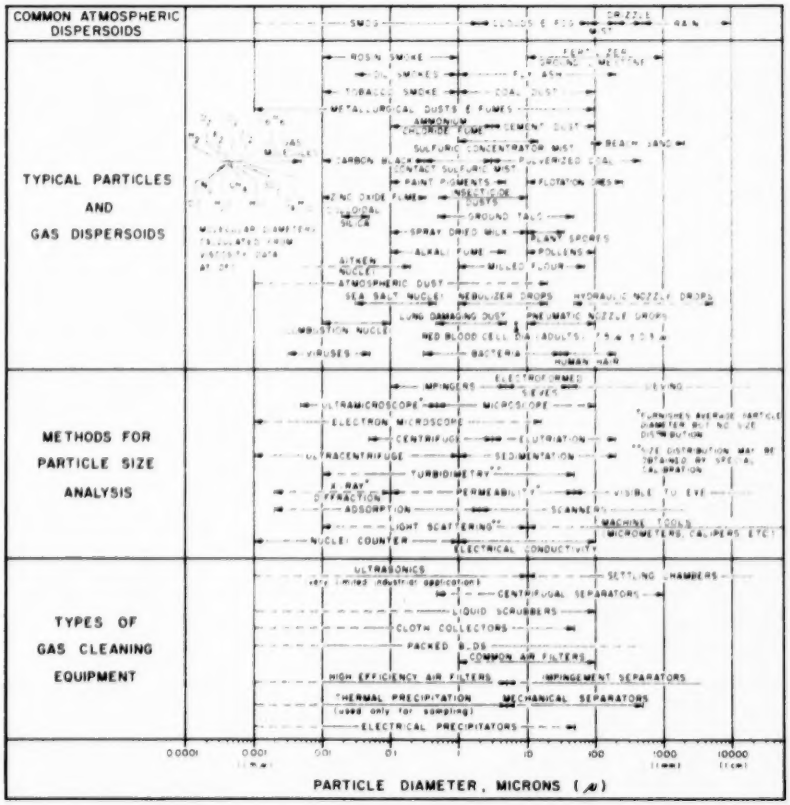
In general, particles smaller than 1 μ in diameter originate in the atmosphere, principally through condensation and combustion. Particles between 1 μ and 10 μ in diameter usually include soil, process dusts and combustion products from industries. Particles larger than 10 μ in diameter generally result from mechanical processes such as wind erosion, grinding, spraying and the pulverizing of materials by vehicles and pedestrians.[4]

FIGURE 7 - TOTAL PARTICULATES

SOURCE AND EMISSION INVENTORY



CHARACTERISTICS OF PARTICLES AND PARTICLE DISPERSION



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G. 1. SOILING INDEX

Soiling index is the usual index of suspended particulate matter in the size range of 0.1 μ to 10 μ. It is not a measure of absolute concentrations as the method of analysis does not measure the deposited mass.

The types of suspended particulate matter identified as soiling index include smoke and fine dust particles. The samples are collected by drawing sample air through a filter paper over sampling cycles of one or two hours. The soiling properties of the sample are measured by the reduction of light transmission through the filter paper. This reduction is reported as a coefficient of haze (COH) per 1,000 linear feet of air sampled.

The guideline that "a minimum of 90% of readings per month shall be less than 1.0 COH" was complied with by all stations, except at ERMU in November, when the average reading was 1.0% out of compliance (Table 10). The lowest average levels for the report period were recorded during the spring and summer seasons, with EIMU recording the lowest levels (Figure 8).

TABLE 10
SUSPENDED PARTICULATE MATTER/SOILING INDEX

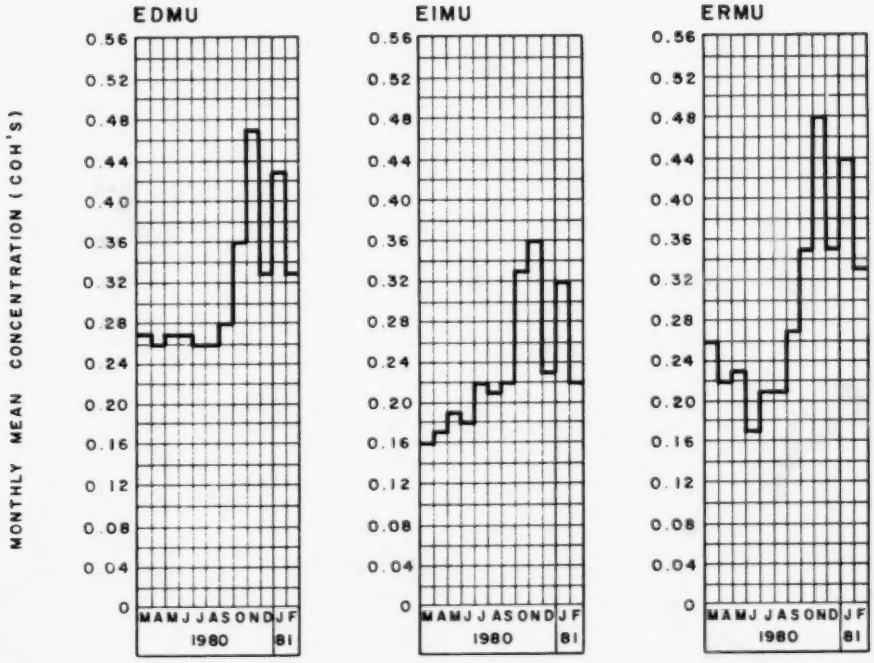
GUIDELINE FOR SOILING INDEX
MINIMUM OF 90% OF READINGS PER MONTH
SHALL BE LESS THAN 1.0 COH

MONTH	ARITHMETIC MEAN (COH)	PERCENTAGE OF TIME INSTRUMENT OPERATIONAL	PERCENT OF READINGS LESS THAN 1.0 COH
EDMU			
March '80	0.27	100	99.6
April	0.26	96.3	99.7
May	0.27	100	99.2
June	0.27	99.9	99.0
July	0.26	100	98.3
August	0.26	93.3	99.6
September	0.28	99.7	98.6
October	0.36	100	98.3
November	0.47	100	96.6
December	0.33	97.4	93.9
January '81	0.43	93.8	93.7
February	0.33	100	98.1
EIMU			
March '80	0.16	96.4	99.9
April	0.17	99.0	98.7
May	0.19	99.5	98.8
June	0.18	100	99.6
July	0.22	78.2	97.9
August	0.21[a]	74.9	99.6
September	0.22	100	97.4
October	0.33	100	92.6
November	0.36	100	93.2
December	0.23	98.7	96.9
January '81	0.32	100	92.7
February	0.22	100	98.4
ERMU			
March '80	0.26	100	97.4
April	0.22	98.5	99.3
May	0.23	90.1	99.0
June	0.17	99.9	99.6
July	0.21	99.6	98.1
August	0.21	99.9	99.1
September	0.27	99.9	95.1
October	0.35	94.8	94.0
November	0.48	99.9	89.0
December	0.35	96.5	92.3
January '81	0.44	99.7	90.6
February	0.33	100	94.6

a.-Instrument operational less than 75%; monthly mean may not be representative.

FIGURE 8 - SOILING INDEX

MONTHLY MEANS



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G. 2. HIGH-VOLUME SAMPLER

Suspended particulate matter is also measured by the high-volume sampler. The sampler consists of a vacuum system and filter housed in a shelter. Suspended particulate matter in the atmosphere is determined by collecting 24-hour samples on the pre-weighed filter. The filter is then reweighed to determine the mass of the particles collected. This method gives a more accurate measurement of suspended particulate matter than the soiling index monitor.

The size of particles collected by the high-volume sampler range from 0.1 μ to 10 μ.

The levels of suspended particulate matter measured by the high-volume sampler (Table 11 and Figure 9) were occasionally in excess of the Clean Air (Maximum Levels) Regulation of 100 $\mu g/m^3$/24-hour at all three stations. No consistent seasonal pattern was apparent; however, average levels were generally lowest during the winter.

There was an average of 59.3% compliance achieved with the Regulation for suspended particulate matter, averaged for all three monitoring stations over the report year. Blowing dust from roads, surrounding fields, construction sites, gardens, etc. are sources which could have contributed to the periods of non-compliance.

TABLE 11
SUSPENDED PARTICULATE MATTER/HIGH-VOLUME SAMPLER

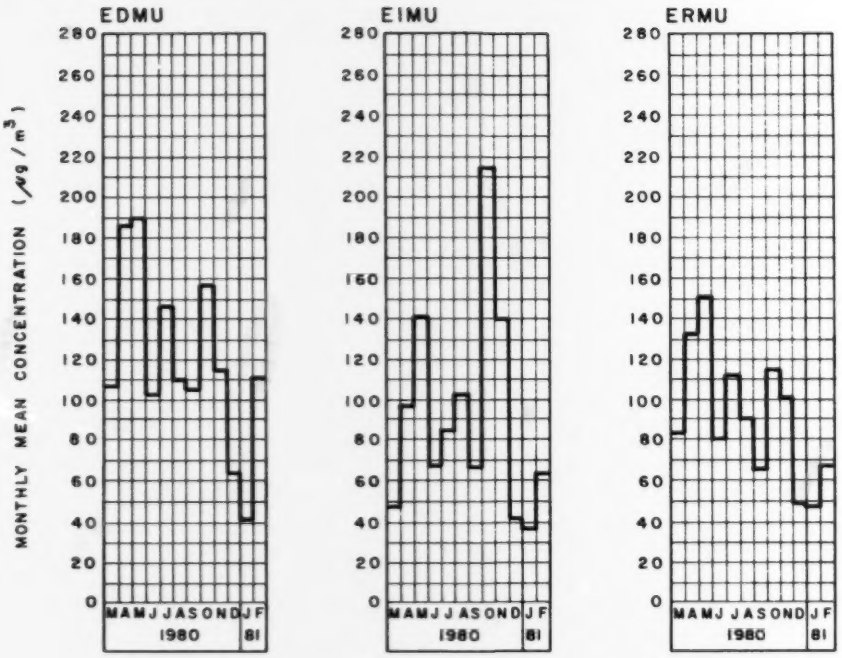
MAXIMUM LEVELS REGULATION
24-HOUR-100 $\mu g/m^3$

MONTH	ARITHMETIC MEAN ($\mu g/m^3$)	PERCENTAGE OF TIME INSTRUMENT OPERATIONAL	PERCENT COMPLIANCE WITH REGULATION
		EDMU	
March ' 80	107	100	60
April	186	100	0
May	190	80	0
June	103	100	60
July	147	100	40
August	110	100	33
September	105	100	40
October	157	100	20
November	115	100	40
December	64	80	75
January '81	42[a]	60	100
February	111	80	25
		EIMU	
March '80	48	80	100
April	98	80	50
May	141	100	40
June	68	100	100
July	85	100	60
August	103	100	67
September	67	80	75
October	215	100	20
November	140	100	60
December	42	100	100
January '81	38	80	100
February	64	100	100
		ERMU	
March '80	83	100	80
April	133	100	20
May	151	100	20
June	80	100	80
July	112	80	50
August	90	100	67
September	66	80	75
October	116	100	60
November	101	100	60
December	49	80	100
January '81	48	80	100
February	68	100	100

a.-Instrument operational less than 75%; monthly mean may not be representative.

FIGURE 9 - SUSPENDED PARTICULATE MATTER: HIGH - VOLUME SAMPLER

MONTHLY MEANS



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G. 3. TOTAL DUSTFALL

Total dustfall includes particles in the size range greater than 10 μ. Since these particles have appreciable settling capabilities, they are collected by deposition in a dustfall jar or cylinder. The dustfall cylinders are generally exposed for 30-day periods and yield integrated dustfall values for that period.

The large particles collected by dustfall cylinders settle readily at low velocities. Therefore, total dustfall cylinders provide a measure of dust arising from local sources. Quite often high dustfall levels are attributable to nearby construction or vehicular traffic on a dusty road.

The results of the monitoring of total dustfall during the 1980 report period are presented in Table 12 and Figure 10. The readings are actual measured levels and are not corrected for "normal background levels." The data indicate that the lowest levels were monitored during the winter months, when there is predominant snow cover.

When the total dustfall levels are compared with the Clean Air (Maximum Levels) Regulations, which distinguish between residential-recreational (53 mg/100 cm^2/30 days) and commercial-industrial (158 mg/100 cm^2/30 days) areas, a high frequency of readings in excess of the Regulations is noted in the residential-recreational areas.

There were averages of 57.1% compliance and 72.1% compliance respectively with the residential/recreational area and the commercial/industrial area total dustfall Regulations. Blowing dust from roads, surrounding fields, construction sites, gardens, etc. are sources which could have contributed to the periods of non-compliance.

TABLE 12

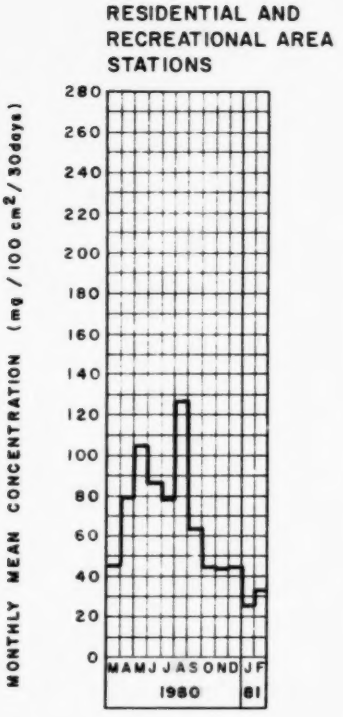
TOTAL DUSTFALL

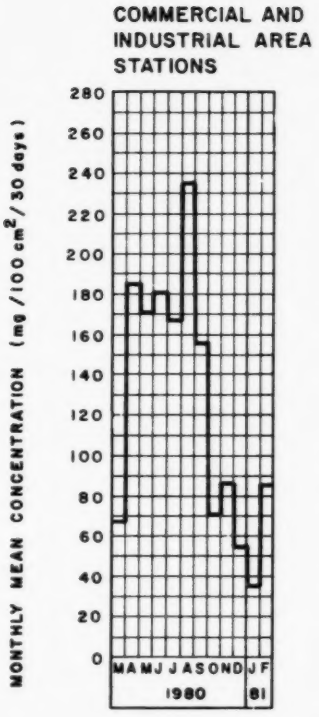
MAXIMUM LEVELS REGULATIONS
53 mg/100 cm^2/30 days in residential and recreational areas.
158 mg/100 cm^2/30 days in commercial and industrial areas.

MONTH	ARITHMETIC MEAN (mg/100 cm^2 /30 days)	PERCENTAGE OF STATIONS REPORTING DATA	PERCENTAGE OF STATIONS IN COMPLIANCE WITH REGULATION
RESIDENTIAL AND RECREATIONAL AREA STATIONS			
March '80	46	100	87.0
April	80	93.3	50.0
May	105	93.3	7.0
June	87	93.3	20.0
July	79	100	26.7
August	127	100	33.0
September	64	100	40.0
October	45	100	73.0
November	44	100	87.0
December	45	100	73.0
January '81	26	100	100
February	33	100	87.0
COMMERCIAL AND INDUSTRIAL AREA STATIONS			
March '80	68	77.8	100
April	185	100	67.0
May	171	100	56.0
June	181	100	44.0
July	168	100	67.0
August	236	100	22.0
September	157	100	67.0
October	71	100	78.0
November	87	88.9	87.0
December	55	100	100
January '81	36	100	100
February	86	88.9	88.0

FIGURE 10 - TOTAL DUSTFALL

MONTHLY MEANS





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V. METEOROLOGICAL DATA

Air pollution levels depend upon atmospheric stability and wind. Stable air near the ground is modified by the input of heat from the city and heat from the sun. Pollutants tend to become uniformly distributed in this modified region which is called the "mixing layer". The height of the mixing layer and the mean wind speed determine the "ventilation", which may be viewed as the effectiveness of pollutant dispersal with respect to urban area sources. Poor ventilation, known also as "stagnation", leads to an increase in pollutant concentrations. Good ventilation will keep the concentrations low.

During the night, the surface of the earth loses heat to space and cools the air immediately above it, forming the nocturnal radiation inversion layer in which the temperature increases with height. The height of this inversion and its intensity control the development of the mixing layer.

To measure these important parameters, wind and temperature soundings were made at a rural station to the south of the city. The data for 1980 are summarized in Table 13.

As compared with 1979, the spring of 1980 had more frequent morning inversions, which extended to greater heights and were of greater intensity. The fall of 1980 had a similar inversion occurrence frequency as in 1979 but the inversions were deeper and somewhat more intense. Afternoon mixing heights were lower than in the previous year. Winter saw somewhat fewer ground-based inversions but they were of greater depth. However, afternoon mixing heights were larger in the winter of 1980/81 than in the winter

of 1979/80. In summary, it appears that the spring and fall of 1980 had a slightly higher meterological air pollution potential than in 1979, while summer and winter of 1980 had an air pollution potential quite similar to that of 1979.

TABLE 13

SUMMARY OF LOWER ATMOSPHERE SOUNDINGS

ALBERTA ENVIRONMENT

ELLERSLIE STATION

Frequencies/Median values	Apr.'80	July'80	Oct.'80	Jan.'81
07:30 MST				
Days with ground-based inversions	10	0	17	-
Ground-based inversion height (m)	365	-	414	-
Potential temperature gradient (°C/100m)	1.7	-	2.9	-
Days with mixing layer	8	20	2	-
Mixing layer height (m)	195	178	694	-
Wind speed in lowest hundred meters (m/s)	5.2	2.3	5.3	-
09:00 MST				
Days with ground-based inversions	1	0	12	13
Ground-based inversion height (m)	108	-	414	513
Potential temperature gradient (°C/100m)	1.0	-	1.9	3.0
Days with mixing layer	18	20	7	6
Mixing layer height (m)	315	447	108	389
Wind speed in lowest hundred meters (m/s)	4.2	3.3	4.5	6.4
12:00 MST				
Days with ground-based inversions	0	0	0	10
Ground-based inversion height (m)	-	-	-	455
Potential temperature gradient (°C/100 m)	-	-	-	3.0
Days with mixing layer	18	18	19	9
Mixing layer height (m)	1058	1070	513	414
Wind speed in lowest hundred meters (m/s)	5.4	3.5	3.3	5.1
15:00 MST				
Days with ground-based inversions	0	-	3	11
Ground-based inversion height (m)	-	-	144	414
Potential temperature gradient (°C/100m)	-	-	1.3	2.4
Days with mixing layer	11	-	12	8
Mixing layer height (m)	895	-	571	455
Wind speed in lowest hundred meters (m/s)	4.3	-	3.6	4.2

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VI. INDEX OF THE QUALITY OF THE AIR (IQUA)

IQUA, introducted in December 1979, is the new way of expressing the air quality index. It is based on the 1-hour and 24-hour concentrations of nitrogen dioxide, sulphur dioxide, and soiling index (COH), on the 1-hour and 8-hour concentrations of carbon monoxide, and on the 1-hour concentrations of ozone. However, instead of calculating a composite index of all five pollutants, as in the old index, an index is now calculated for each of the five pollutants. The maximum index is then used as the numerical value of IQUA. An IQUA reading of 0-25 indicates good air quality, 26-50 is fair, 51-100 is poor and greater than 100 is very poor.

In Edmonton, the IQUA is calculated at three locations: EDMU, ERMU and EIMU, with the index made available to the media and public routinely. It is issued at 0800 and 1500 hours on weekdays, except when the index values are greater than 50. In the latter case, it is generally issued every hour until the index value falls below 50.

A summary of the air quality indices for the three monitoring stations is presented in Table 14. During the report year, the air quality was generally good (0-25 as an arithmetic mean). On occasion, however, index values in the poor category were observed. Such values were usually a result of high soiling index levels.

TABLE 14

INDEX OF THE QUALITY OF THE AIR (IQUA)

	EDMU	EIMU	ERMU
MONTH	ARITHMETIC MEAN	ARITHMETIC MEAN	ARITHMETIC MEAN
March '80	22	18	18
April	20	19	18
May	20	20	16
June	18	15	15
July	16	14	14
August	15	11	13
September	17	13	16
October	21	19	19
November	25	20	26
December	22	15	19
January '81	27	21	24
February	24	16	22

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VII. SUMMARY AND CONCLUSIONS

From the foregoing analysis of the data, the following can be concluded:

1. During the report year, the air quality index in the Edmonton area was generally in the "good" range (0-25 as an arithmetic mean).
2. All nitrogen dioxide readings were 100% in compliance with the Regulations, with the exception of 99.9% compliance in May 1980, and 99.8% compliance in January 1981 with the 1-hour Regulation at EDMU. Vehicular traffic exhaust is responsible for the small amount of non-compliance time.
3. High natural background ozone levels in Alberta resulted in a significant number of readings in excess of the 24-hour ozone Regulation. There was 83.0% compliance with the 24-hour ozone Regulation, averaged for all three monitoring stations for the report year. Good compliance was achieved with the 1-hour ozone Regulation (average of 99.97% compliance for all three monitoring stations for the report year).
4. There were averages of 99.8% compliance and 95.5% compliance respectively with the 1-hour and the 8-hour carbon monoxide Regulations, averaged for all three monitoring stations for the report year. Vehicular traffic exhaust is responsible for the small amount of non-compliance time.
5. All sulphur dioxide readings were well below the Regulations, resulting in 100% compliance.

6. All soiling index (coefficient of haze-COH) readings were 100% in compliance with the Alberta guideline, with the exception of November, 1981 at ERMU, when the average reading was 1.0% out of compliance.

7. There was an average of 59.3% compliance with the Regulation for suspended particulate matter (0.1 μ to 10 μ size range), averaged for all three monitoring stations over the report year. Blowing dust from roads, surrounding fields, construction sites, gardens, etc. are sources which could have contributed to the periods of non-compliance.

8. There were averages of 57.1% compliance and 72.1% compliance respectively with the residential/recreational area and the commercial/industrial area total dustfall (greater than 10 μ size) Regulations. Blowing dust from roads, surrounding fields, construction sites, gardens, etc. are sources which could have contributed to the periods of non-compliance.

VIII. REFERENCES

1. U.S. Department of Health, Education, and Welfare. Air Quality Criteria for Nitrogen Oxides. (NAPCA Publication No. AP-84. Washington, D.C., January 1971); sec. 11, p. 8.

2. Alberta Environment, Research Secretariat. A Study of Photochemical Air Pollutants in the Urban Airsheds of Edmonton and Calgary, by H.S. Sandhu. (Staff Report #1. Edmonton, Alberta, 1975).

3. Alberta Environment. Industrial Sulphur Emissions for Alberta 1977-1981, prepared by Alberta Environment, Pollution Control Division, Air Quality Control Branch. September 1982.

4. U.S. Department of Health, Education, and Welfare. Air Quality Criteria for Particulate Matter. (NAPCA Publication No. AP-49. Washington, D.C., January 1969); p. 181.